Analysis of Planar E+I and ER+I Transformers for Low-Voltage High-Current DC/DC Converters with Focus on Winding Losses and Leakage Inductance

In this paper an analysis of two planar transformers designed for high-current switching applications is presented. Typical converter application is represented by fuel and electrolyser cell converters. The transformer designs are based on E+I and ER+I planar cores while the analysis focuses on winding resistance and leakage inductances which represent the main concerns related to low-voltage high-current applications. The PCB winding design has a one to one turn ratio with no interleaving between primary and secondary windings. The main goal was to determine if ER planar core could provide a significant advantage in terms of winding losses compared to planar E cores. Results from finite element analysis highlight that low frequency winding resistance is lower for the ER core since it is dominated by the lower mean turn length however, as the AC-resistance becomes dominating the winding eddy current losses increases more in the ER core than in the E core design. Calculated and simulated leakage inductances for the analyzed cores do not show relevant differences. A laboratory prototype based on E64 planar core is used as reference. Laboratory measurements highlight that FEM analysis provides more realistic results when computing the winding AC-resistance.

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